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# THE INFLUENCE OF NATIONAL CULTURE IN INFORMATION TECHNOLOGY PRODUCT ADOPTION

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## Abstract

*Empirical studies on the impact of national culture on Information Technology (IT) product adoption are rare. In this paper, it is postulated that national culture plays a significant role in IT adoption. Empirical evidence is provided based on IT product adoption data for thirty nations over a period of ten years. A 7-IT set (Computers, PC, Telephone, cell phone, Fax, the Internet, Pagers) is considered for this study. These ITs are most frequently used in industry. The results show that even after controlling for economic and other significant national indicators, national cultural dimensions play a statistically significant role in most IT product adoptions. The result has implications for IT vendors, multi-national firms and cross-cultural researchers.*

**Keywords:** National culture, adoption, information technology, pooled regression

## Introduction

The world-wide growth of information technology (IT) is phenomenal. In 2002, the IT spending grew to US\$ 1 trillion. Worldwide, IT spending grew by more than 10 percent annually during much of the past decade -- a pace faster than the global economy overall (Microsoft, 2002). In many countries, IT spending grows at two to five times the rate of overall economic growth.

According to ISWORLD net page on global information technology (<http://www.american.edu/MOGIT/git/aboutbib.htm>), the cross-cultural nature of information systems can be studied in terms of (1) the impact of constant information on people of different cultures; (2) the differences in information sought and used by people of different cultures (and the strategies and approaches to decision making and other task performance by people of different cultures); and (3) the mechanisms for developing information systems to be developed and/or used by people of different cultures. The second point clearly assumes that different cultures adopt and use ITs differently. The third point addresses the need to develop ITs tailored to the need of people of various cultures. It is important to know, how much national cultural factors contribute to growth of ITs in various nations. The present paper, therefore, attempts to empirically measure the impact of national culture on IT adoption.

Rapid globalization has made it necessary to investigate how IT gets adopted in various nations. As Straub et al. (1997) mention, there is a need to exploit the power of IT to communicate among geographically dispersed nations. Managers need to learn about cross-cultural adoption and use of IT in order to be able to adopt IT successfully. Robey and Rodriguez-Diaz (1989) mention that culture may impede IT implementation efforts because the differences in the way ITs are interpreted and given meaning. Watson et al., (1994) while studying the cross-national adoption of GSS systems observed that culture will shape the adoption of technology. Culturally compatible feature of a technology will be appropriated and the remaining features of the technology will be reshaped to satisfy cultural norms or ignored. Harvey (1994) and Krumholtz et al., (2000) mention in their cross-national studies of IT implementations that national culture impacts information system design in myriads of way.

A number of examples suggest that there is a relationship between culture, as well as other national-level factors, and IT adoption. For example, there are differences in the growth of computerization in different cultures. In recent times, there has been a rapid growth in computerization within some Asian countries, known as Asian Tigers, and low growth in some African countries. Economic factors alone cannot always explain the disparity in such growth patterns. Also, the adoption of mobile telephony has been uneven across nations and the rate of growth is arguably not related only to economic factors. A recent report (Intecom, 2000) noted that 75 percent of the people in Finland and Iceland used mobile telephones compared to about 40 percent in the US, although the US economy had been stronger than the Finnish economy (The GDP per capita of the US and Finland in 1990 were \$18,399 and \$14,216 respectively). Goodman et al. (1991) have stated that “there are important historical, social, cultural and economic reasons for computing and telecommunication disparities (among nations) and, for better or worse, these differences make the world a more complicated and interesting place” (p. 19). As mentioned earlier, the relationship between culture and the diffusion of information technologies has been studied, but no rigorous empirical investigation of this relationship has been conducted on a cross-national basis, involving a large number of nations.

A few empirical studies have investigated the relationship between national culture and IT adoption (Straub, 1994, Straub et al., 1997). For example Straub et al., (1997) found that the technology adoption model (TAM) could not predict technology use across all cultures. They conjectured that national culture played a role; however, they exerted caution. At the end of their study, they conclude: “It is not possible to say with certainty that a link between cultural factors and technology has been empirically established”. In order to do that one needs to control for other national variables. National variables such as GNP (or GDP) per capita are important. To quote Hofstede (2001, p. 68), “If hard variables (economic, biological, technological) predict a country variable better, cultural indexes are redundant.” He encourages researchers to use GNP per capita as an additional variable, to examine the effect of culture. This paper attempts to do that. The IT products studied in the present work are Computers, Personal computers (PC), telephone, cell phones, Fax, the Internet and Pagers. These are some of the key IT products that get used in personal and business environment in most nations.

### ***National Culture***

National culture has been defined as a set of core values that shapes the behavior of individuals as well as the whole society (Adler, 1997). Once set in place, culture has its own independent effect. Scholars often overlook the importance of culture.

There is a strong relationship between culture and economic development as well as culture and social and political systems (Inglehart and Baker, 2000; Granato et al., 1996). Inglehart (2000) pointed out the difficulty of proving the direction of causality. However, his empirical cross-sectional study provides evidence that a strong positive relationship exists between culture and national economy.

The following discussion primarily focuses on the contributions in culture of Hofstede (2001). His work embodies the ideational perspective where culture is interpreted as the practices, beliefs, and values of individuals within a given system. Emphasis is given to beliefs and values of an aggregate number of individuals.

### ***Hofstede's Work***

According to Hofstede, culture is equivalent to the collective mental programming of a group, tribe, minority, or a nation. It is the aggregate of individual personality traits. Hofstede developed an empirically based typology of cultural attributes by analyzing data obtained from surveys conducted among individuals in 53 nations in 1968 and 1972. Since all 116,000 respondents were employees of the same firm, the IBM, Hofstede was able to hold constant the influence of corporate culture. Based on the data obtained, he classified countries along four dimensions: power distance, uncertainty avoidance, individualism/collectivism, and masculine/feminine. Hofstede rated each of the 53 countries in his study by these cultural dimensions (Hofstede, 2001). For example, compared to some other cultures the US is high in individualism, low in power distance, high in uncertainty avoidance, high in masculinity. In spite of some criticisms, Hofstede's research has been widely cited. Sondergaard (1994) noted that his research has provided both a theoretical paradigm as well as data used in other studies. Moreover, others have replicated Hofstede's work and provided validation for his observations.

## Culture and IT Adoption

The studies on culture and IT adoption can be divided in two parts (Robey and Rodriguez-Diaz, 1989):

- The effect of national culture on IT (Ein-Dor, Segev, and Orvad, 1993; Straub, 1994) and
- The effect of organizational culture on IT (Burkhardt, 1994; Cooper, 1994; Robey, Gupta, and Rodriguez-Diaz, 1992).

This paper deals with only national culture and so we focus on the first part of the existing literature. Ein-Dor et al., (1993), Palvia (1998) and Gallupe and Tan (1999) have all suggested that national culture is an important factor in global information management. Several empirical works have studied the influence of culture on IT adoption. Straub (1994) discussed the impact of culture on E-mail and fax use in U.S and Japan. Hill et al. (1998) did a study on impact of beliefs and values on IT transfer in Arab countries. Hasan and Ditsa (1999) studied the IT adoption in West Africa, the Middle East and Australia and observed that culture was an important factor in differences in the impact of IT in those countries. Phan and Oddou (2002) similarly tried to explain IT adoption in Vietnam in terms of culture.

The Technology Adoption Model (TAM) (Davis, 1989) is a central model in information technology adoption and several authors have also investigated the impact of culture on TAM. TAM assumes that beliefs such as perceived ease of use and perceived usefulness of the technology are main determinants of the attitudes toward a new technology. These attitudes in turn, influence intentions and, ultimately, behavior or IT usage. In the TAM, intention drives usage. Many empirical studies on TAM have shown that it has a reasonable explanatory power (about 40% of the variability of the dependent variable Use). TAM is a good predictor of technology adoption and usage (Taylor and Todd, 1995; Davis, 1993).

Straub, Keil & Brenner (1997) tested TAM across three nations--Japan, Switzerland and the U.S. Rose & Straub (1998) applied TAM to the Arabic World. The fit of TAM in Japan was insignificant whereas it was found to be a better fit in Arab nations as well as in Switzerland. These differences in fit have been ascribed to the influence of national culture. Mao and Palvia (2002) also did a study on impact of a cultural dimension on TAM in China and observed that normative beliefs and subjective norm get influenced by some national cultural dimension

### *Studies on Hofstede's Dimensions and IT Adoption/Use*

As reported by Kambayashi (2002), the relevance of Hofstede's work on IT adoption has been demonstrated by the number of subsequent studies which have used its national cultural dimensions (Straub, 1994; Harvey, 1997; Mejias et al., 1997; Watson, Teck and Raman, 1994; Krumbholz et al., 2000). These studies have examined the implications of national culture for specific technologies such as MIS and GDSS; E-mail and Fax etc, involving typically two to three nations.

## Hypothesis Development

The following are brief descriptions of Hofstede's cultural dimensions.

Individualism and Collectivism (IC). Individualism refers to a loosely coupled social network where people take care of themselves. In contrast, collectivism refers to a tightly coupled social network where the group feeling is very strong. For example, in cultures where individualism is high, employee loyalty is considered more important than efficiency. IT adoption in individualistic nations will be greater as individuals pay more attention to personal lives, freedom in work and more performance-oriented and ITs such as mobile and personal computers, the Internet are more supportive of these values.

*Hypothesis H1: Information technology adoption is greater in nations with high individualism.*

Power Distance (PD). This measure refers to the extent to which a society accepts the unequal power distribution within or between institutions and firms. A high-power distance society means that people in that culture more readily accept wider differences in power compared to low power difference cultures. For example, in some high-power distance cultures, management decisions will mostly be centralized and hierarchical. In low power distance cultures, management decision will be decentralized and more participative. Low power distance societies have more need for technologies, more modern industries and have technological momentum of change. This societal norm suggests a positive relationship between low power distance and IT adoption, when adoption levels are concerned.

*Hypothesis H2: Information technology adoption is greater in nations with low power distance*

Uncertainty Avoidance (UA). This cultural attribute describes the extent to which individuals feel threatened by uncertain and ambiguous situations, and try to avoid them. In a culture with high uncertainty avoidance, mechanisms are created to reinforce and reduce risks. Thus, firms in these nations, may have more rigid rules and exhibit less tolerance for uncommon ideas and behaviors. This dimension is related to need for security, dependence on experts, and the application of information. The societal norm in countries with low UA scores includes a tolerance for uncertainty (Hofstede, 2001). Computers, and personal computers, in particular, can routinize jobs, thus reducing uncertainty. Telecom products such as telephones, fax machines and cell phones can reduce uncertainties in communications. Calculated risk taking in IT adoption, however, is a standard way of doing business in many nations. Any IT adoption involves risks, especially new ones. On balance, this societal norm suggests a negative relationship between UA and IT adoption, when adoption levels are concerned.

*Hypothesis H3: Information technology adoption is lesser in nations with high uncertainty avoidance*

Masculinity and Femininity (MF). This is a dichotomous attribute. To the extent that a culture is feminine, the values of human relationships and concern for others are high. On the other hand, masculine cultures are more assertive and value materialism. Assertiveness, performance, success and competition are key factors in masculine culture; quality of life, service, care for the weak etc. are the hallmarks of a feminine culture. ITs promote more cooperation at work, better quality of life and these values are espoused in nations with low MF index.

*Hypothesis H4: Information technology adoption is greater in nations with low values in MF index, i.e., low masculinity*

Our final hypothesis is concerned with other variables. We postulate that national culture is significant, even after controlling for economic and/or heterogeneity factors of a nation. The heterogeneity factor could be important as many nations have a heterogeneous population and IT adoption like economic growth can be different in a heterogeneous context, as compared to a homogeneous context (Mauro, 1995).

*Hypothesis H5: Controlling for economic and other indicators, culture will play a significant role in IT adoptions*

## Information Technologies Investigated

A set of seven information technologies was studied. The information technologies include personal computers (PCs), telephones, cellular phones, pagers, fax machines, the Internet and computers. The data on various technologies were collected from multiple sources, obtained after a comprehensive effort to ensure that all possible data sources were examined. The data obtained cover all of the products reasonably well for the relevant time period. It is argued that because adoption patterns repeat themselves over time, the results based on the data available are robust and generalizable.

Among these ITs, telephone has been around for quite sometime (more than a hundred year in some nations), whereas some ITs such as the Internet is comparatively new (de Sola Pool, 1981). The Computer is a broader set consisting of PCs, Workstations, midframes and mainframes in use, although PCs account for most of the computers in all nations.

**Table 1. Sample Data for Five Nations**

Nations/1995	PC	Telephone	Cell phone	Internet	GDP Per Capita	UA	IC	PD	MF
The U.S.	328.09	607.2	128.44	23.019	27712.99	46	91	40	62
India	1.29	12.9	.0083	8.49E-04	380.07	40	48	77	56
Germany	178.45	513.3	45.53	5.798	30110.12	65	67	35	66
France	146.94	560	22.52	2.6002	26850.33	86	71	68	43
Brazil	17.33	85.1	8.25	.1291	4415.37	76	38	69	49

Table 1 shows adoption data for a few ITs, GDP per capita and four Hofstede cultural dimension values for five sample nations, the US, India, Germany, France and Brazil. The IT data are in units per 1000 with Internet measured by number of Internet hosts per 1000. The GDP is measured in GDP per capita (constant 1995 US\$). The data show enough variability even for only five nations. The set of nations, consisting of mostly developed nations and a few underdeveloped nations used in the study (due to data availability) is given below:

Australia, Austria, Brazil, Canada, Chile, Denmark, Finland, France, Germany, India, Ireland, Italy, Japan, S. Korea, Mexico, Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Portugal, S. Africa, Spain, Sweden, Switzerland, Turkey, the UK, Uruguay, the US, Venezuela.

The Internet adoption data additionally contained a few more nations (a set of forty-one nations).

## Data and Research Design

### Data

Data for the Computers were obtained from Juliussen and Juliussen (1998). The data for the rest of the ITs were collected from World Bank and ITU databases. The cultural data were obtained from Hofstede's (2001). The ELF index value was obtained from Mauro's work (1995). Data for other variables were obtained from the World Bank and ITU databases. Data for six ITs were collected from 1989 to 1998 for four years (1989, 1992, 1995, 1998). Computer adoption data was also used for the period 1980-1995 from four representative years (1980, 1985, 1990, 1995).

### Research Design

The independent variables considered were; cultural dimensions proposed by Hofstede; institutional dimensions such as ELF, economic variables such as GDP per capita. The index called ELF (Ethno-linguistic Fractionalization) is used in this study and it represents heterogeneity level of a nation's population. Although this index was used by Mauro (1995), the original data source is the department of Geodesy and Cartography, USSR which gathered the data (Atlas Narodov Mira, (Moscow, 1964)). This index will be used as a control variable in the present study, to control for the differences in IT growth emanating from heterogeneity of a nation's population. For the combined regressions, we also used GDP per capita and ELF as controls (Barro, 1997).

The OLS regression analysis may create several problems. First, the issue of normality of residuals (OLS assumes normality of error terms). Second, the problem of heteroscedasticity (i.e., error variance is not constant over all cases). This violates one of the fundamental assumptions of OLS. The use of dummy variables can reduce this problem. Yet another problem is autocorrelation when dependent and independent variables exhibit correlation over time. Lag of some explanatory variables or indicator variables for seasonal trends can be used in regression to solve this problem. Finally the issue of multicollinearity (when explanatory variables are correlated) arises. One can combine or delete some explanatory variables if these can be allowed in the model. Another alternative could be the use of ridge regression to get rid of multicollinearity.

Panel data may introduce another type of error—contemporaneous correlation among variates. Panel corrected standard error can be used to address this problem (Greene, 2000).

For the present study, a pooled OLS multiple regression scheme for each IT in which data were pooled into a panel of time-series from different cross-sectional units was employed at the initial stage. The panel was an unbalanced one, as, for a given IT, all nations did not have data for all the years under consideration. Dummy variables were added to the data: one for each nation and one for each year. As a result, the degree of freedom increased with the increase of the number of observations. The design was a fixed-effect, where dummies were used to capture systematic differences among panel observations. Fixed-effect assumes that each nation differs in its intercept term. Dummies for all but one year and all but one nation were used in the regression.

Each IT data set was combined to form the final data set. Thus, data sets were combined to contain time series and cross national data and various ITs. Finally dummy variables were introduced for each IT and each year and each nation in the regression, resulting in a fixed effect design. The final pooled data set yielded 517 data points and the number of nations was around thirty. Most of these nations were European or North American or from the OECD group, with a few third world nations. This combination of nations resulted from data availability.

The pooled regression methods used a step-wise regression scheme. To test whether cultural indicators play any role in IT adoption, a worst-case analysis scheme was employed. The cultural variables were introduced after all other relevant indicators in the regression.

## Results and Discussions

Pooled regressions were done on IT s and computers and the results are described in Table 2. The normality of the residuals of the main regression model could not be rejected from the normal graph as well as from the tests conducted. The Shapiro- Wilk statistic value for standardized residuals was .977, which is an acceptable high value for normality. The overall data set was also tested for heteroscedasticity using White’s test. The result showed that  $nR^2 (76.29) < ?^2 (519)=124$ , thus indicating absence of heteroscedasticity. The presence of serial correlation in data was verified by Durbin-Watson test statistic, which was later eliminated by using lagged variables. Multicollinearity in independent variables was negligible (VIF values for the 5 independent variables ranged from 1.6-3.2, much less than 10, a suggested cut-off number for multicollinearity in literature). Multicollinearity in the overall data, however, was not completely negligible in the final pooled regression model as many dummy variables were introduced which aggravated the multicollinearity problem. Eliminating dummy variables may result in deficiency in the fixed-effect structure.

### Culture with ELF as Control: Pooled Regression

All the cultural indicators emerged as significant in more than one regressions. Refer to Table 2. How much variance in IT adoption can the cultural indicators explain? When considered in isolation, the Hofstede’s cultural group can account for 25%-99% of the variance in IT adoption.

### Culture with GDP and ELF as Controls: Pooled Regression

When controlling for ELF and GDP variables, the variance explained by Hofstede’s cultural variables was still significant for all ITs (Table 3). We studied 4 ITs and the final set of 6-ITs. It appears that culture is significant and a match is found in approximately 50 % of cases. The contribution of Hofstede’s cultural dimensions are statistically significant in case of all ITs, varying from 1%-6%.

**Table 2. IT Adoption Regression Using Hofstede’s Dimensions. Control Variable is ELF.**  
(+: significant in 1-tailed t test)

Information Technology Product	Variable(s) with Significant t	Adj R <sup>2</sup>	N	Range of Years
Computers	PD(-), IC(+)	.25	107	1980-1995
PC	IC(+), UA(-)	.85	97	1988-1998
Internet	IC (+), PD(-)	.93	112	1992-1998
Telephone	IC (+), PD(-), MF(-), UA(+)	.99	98	1988-1998
Cell phone	UA(-)	.71	92	1988-1998
Pager	IC(+) <sup>+</sup>	.69	75	1988-1998
Fax Machines	--	.13	84	1988-1998
6-IT data set	IC(+), UA(-) <sup>+</sup>	.77	519	1988-1998

Table 4 summarizes the results from Tables 2-3. Support for hypotheses 1 and 5 can be found in most cases. Support for hypotheses 2, 3 was modest. Finally, support for hypothesis 4 was weak.

**Table 3. IT Adoption Regression Using Hofstede's Dimensions. Control Variables are GDP and ELF.**

Information Technology Product	Variable(s) with Significant t	Adj R <sup>2</sup>	N	?R <sup>2</sup> Due to Culture	No. of Matches
PC	PD(-)	.88	83	.04	1/4
Internet**	IC (+), PD(-), MF(-)	.93	112	.01	3/4
Telephone	IC (+), PD(+), UA(-)	.98	98	.06	2/4
Cell phone	MF(-), UA(-)*	.71	92	.04	2/4
6-IT data set	MF(-), IC(+)	.77	519	.01	2/4

\*\* dependent variable in log; \*: p<.10

**Table 4. Summary of Results**

Hypothesis	Supported in Number of Cases	Significant Cultural Variable(s)	Remark
Hypothesis 1 supported?	9/13, 4 N.S.	IC	Supported
Hypothesis 2 supported?	5/13, 1 opposite sign, 7 N.S.	PD	Moderately supported
Hypothesis 3 supported?	5/13, 1 opposite sign, 7 N.S.	UA	Moderately supported
Hypothesis 4 supported?	4/13, 9N.S.	MF	Weakly Supported
Hypothesis 5 supported?	13/13	At least one of the above 4	Supported

## Conclusions

This preliminary study was motivated by lack of empirical analysis of the impact of national cultural attributes in IT product adoption. This study found that national cultural indicators are important for explaining the variability in IT adoption. Empirical data for 30 nations over a ten-year period of time for adoption of 6-ITs were examined. For computers, the period length was 15 years. The data sets consisting of roughly 90--550 data points were robust enough for generalization. The study also found that national culture, makes a statistically significant contribution to IT diffusion, even after controlling for other relevant national indicators such as GDP per capita and heterogeneity index. This shows that even after controlling for the income-level, cultural practices of humans still matter in IT product adoption. The study used Hofstede's cultural dimensions. Other cultural dimensions such as Inglehart's (2000) also show similar results.

There are several limitations to the study. First, although exhaustive investigations have been made by the first author on relationship of other type of independent variables in combination with culture, it is not reported in the present paper (Bagchi, 2001). Second, the contribution of culture, when considered in combination with other variables, is not clear. There exists a complicated relationship among all types of indicators, which needs to be investigated. Separating out the effects of each type of indicators is, however, a challenging task. For panel data, more rigorous statistical tests may be needed which is presently been done. Finally, the study is based on level models. A similar study is needed with rate models. Work is presently going on in these areas.

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